U.S. DEPARTMENT OF AGRICULTURE FOREST SERVICE FOREST PRODUCTS LABORATORY MADISON, WISCONSIN

entering the age of WOOD

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The Forest Products Laboratory is the national center for wood processing and product research. It is maintained in Madison, Wisconsin by the Forest Service, U.S. Department of Agriculture in cooperation with the University of Wisconsin.

THE NEW AGE OF WOOD

Troglodyte warriors found that a pointed, wood stick was often a more effective weapon than a club. As time went on, other primitive warriors found that attaching a stone point to the wood shaft made an even better weapon. Rather than improve the wood in the spear, cavemen liked the novelty and effectiveness of stone points, encouraged their use, and moved from stone to bronze, and then iron, steel, and a host of other nonrenewable materials. Thus, these early men started a pattern of resource use that would eventually bring us into our present time of shortages.

We need now to look back at those first men and say to ourselves, "Perhaps wood was the better idea."

Supplies of metal, plastic, and petro-chemicals are limited. The emerging nations of this world are competing intensely for the declining finite stocks of these nonrenewable materials. These materials can only become more scarce and more expensive.

An even more drastic situation can be seen when we look at fuels. Not only is world consumption of these vital substances accelerating at an ever increasing rate, but the known supplies are even less available than many other nonrenewable materials. This energy shortage is aggravated by the use of many nonrenewable materials since their recovery and processing demand large quantities of energy.

Amidst this spate of shortages, one single material promises to be available continually as we enter the new age. It is abundant, can be used for almost any purpose, has low energy demands for processing and use, and can be grown in perpetuity. That substance of course, is wood.

However, the new age of wood will not be an age of abundance unless we take steps to make it so. Predictions made by the Forest Service indicate that wood may be in critically short supply by the year 2000. Extensive efforts are needed to grow more timber and to find ways to extend the resource through more efficient utilization of what is cut. The latter course holds great promise for both present and future.

The Forest Products Laboratory works with both government and industry timber managers to provide information on methods for increasing the yield of each harvested tree. The Laboratory's research findings, with the objective of attaining better and more efficient use of timber and better serviceability for the consumer, are implemented through direct consultation and cooperation with the State and Private Forestry arm of the Forest Service and wood-using industries

Efficient utilization of wood is what this report is all about. The research results contained herein will light the paths that lead to the new age of wood.

H O Fleischer
DIRECTOR

BOF - A COMPUTER RUNS THE SAWS

Computerized decision-making will help sawmillers of the future produce more lumber from each tree and thereby help conserve the resource.

Forest Service projections indicate that impending timber shortages are likely to cause softwood lumber prices to rise 50 percent in relation to most other commodities between 1970 and the year 2000. This inflationary prospect for lumber can be alleviated through more efficient use of each harvested tree.

The Forest Products Laboratory's innovative research action program, Project STRETCH, is directed towards extending the national timber supply by increasing the yield and efficiency of lumber-type products. One part of Project STRETCH is a computer program and associated technology which could be the answer to the age-old quest for higher lumber yields.

The system is called Best-Opening-Face or BOF for short. It solves, with flawless accuracy, the geometric problem of obtaining the maximum volume of rectangular lumber from logs whose basic shape is that of a tapered cylinder.

A Laboratory sawmilling expert recognized that the exact position of the first cut, or opening face which controls the location of all subsequent cuts, had a significant effect on the volume of lumber recovered from each log. Misjudging placement of the opening face by only a fraction of an inch can reduce lumber recovery by as much as 30 percent.

At the speed logs pass through most mills, it is physically impossible for a sawyer to select the best opening face for each log. The solution to this problem is a system utilizing an electronic eye for accurately measuring the log, an electronic mini-computer brain for deciding how to cut it, and numerically controlled machinery to position the log and the saws. These elements of BOF are readily available and can be adapted to most mills.

Computer controlled sawing can increase lumber recovery at most mills by a conservative 10 percent. The additional yield will, within one year,

more than pay for a medium-size mill's $150,000 investment in BOF technology.

BOF's potential for increasing lumber yield is especially good with smaller logs. Since over 15 billion board feet is already being cut from small softwood logs annually without benefit of BOF, the potential for increased yields is great.

Lumber recovery can also be improved for all timber through using machinery and procedures to reduce saw kerf and planing and sawing variation allowance. A study conducted for the Forest Service by H. C. Mason, a forest industry consulting firm, indicated that lumber output could be increased a conservatively estimated 15 percent by improving sawing equipment and tightening up mill procedures.

PRESS-LAM

Press-lam is a new way to produce lumber. The system follows Mother Nature's geometry by rotary knife-cutting a log instead of sawing it into chunks.

Producers using press-lam techniques will get 30 to 50 percent more lumber than a conventional sawmill can from the same quantity of logs. Knife-cutting eliminates sawdust and the smooth surface left after cutting does not have to be planed. This process produces good quality structural lumber from low grade trees in dimensions greater than the size of the raw material; all at a cost comparable to conventional sawing and processing.

Lumber as wide and long as desired can be made by controlling placement of rip and crosscuts. Therefore, it is possible to get a board 14 inches wide from a 10-inch tree.

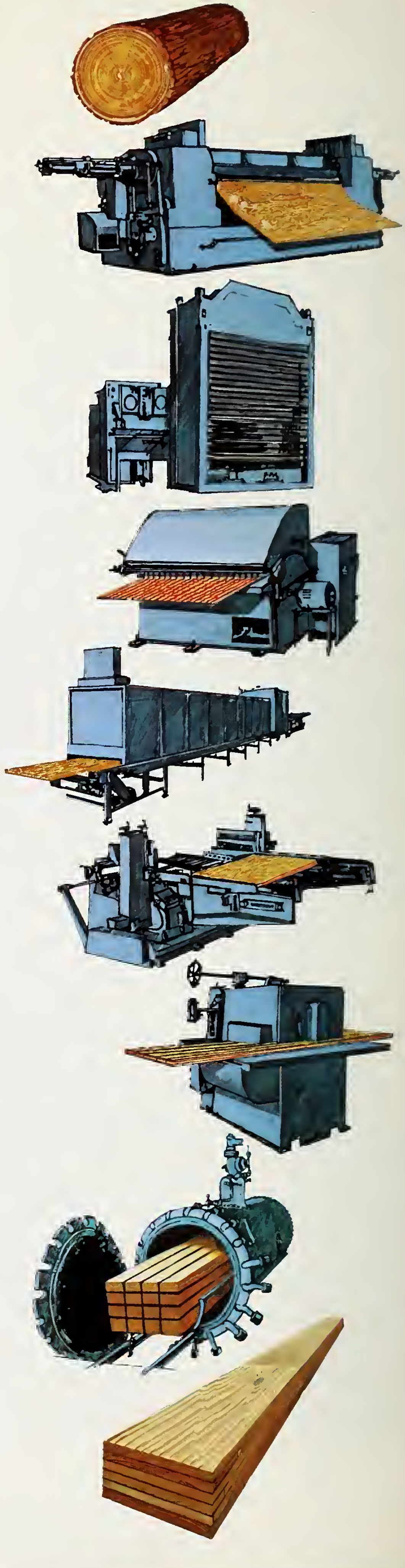
Press-lam structural lumber is also of higher and more uniform structural quality than that which could be obtained from sawing the same trees. Defects in one-ply are almost always backed by sound wood in the adjoining layers, so their adverse effects are reduced. Lumber suppliers benefit from reduced inventory costs since they can cut lumber to order from continuously produced sheets.

Press-lam can be used for a wide range of products—from railroad ties to bridge decking to structural framing in houses. It is especially suited to production of specialty lumber without limit to length or width.

Press-lam lumber is much easier to treat with preservatives than conventionally sawn lumber—a good property for railroad ties or bridge material. Its tendency to upgrade the raw material makes it valuable in utilizing much of the low quality hardwood now unused.

Press-lam lumber can be manufactured with currently available wood processing equipment. It borrows the veneer lathe and clipper, hot press (for press-drying), glue spreader, laminator, and trim saw used by other processors; assembles them in line; and converts wood from log to finished product in less than 30 minutes.

Heated logs (some species such as Douglas-fir can be peeled cold) are put on the lathe



and peeled into veneers up to one-half-inch thick. These veneers are clipped into sheets and press-dried in a rapid new process, producing a flatter and more stable product than that obtained by conventional drying. Then after coating the veneers with glue while they are still hot and laminating them in an overlapping fashion into a wide, continuous sheet of desired thickness, the press-lam material can be crosscut and rip sawed into lumber of the desired dimensions as soon as the glue cures. Press-lam lumber differs from continuous sheets of plywood, because all veneers are assembled in parallel-to-grain orientation.

PAPER PLENTY FROM RESIDUE

Wood's most versatile product line is proving the least choosey about its raw materials. Paper producers already recycle much waste paper to obtain the fibers they need. Soon, with the help of the Forest Products Laboratory, they may feed their factories with the forest residue now left in the woods.

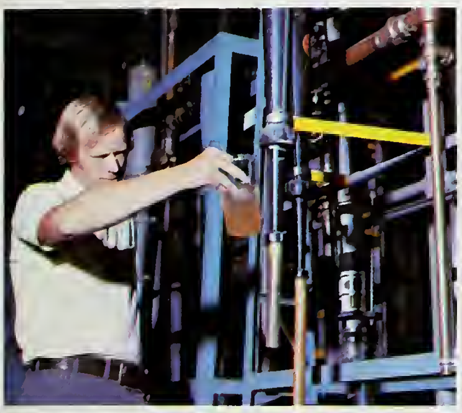
Residues have not looked too good as a raw material because their small size or irregular shape makes bark removal difficult. FPL research has proved that not only is bark removal unnecessary, but leaving it in the chip supply can actually increase pulp yield on a cordage basis and reduce pulp production cost.

Experiments at the Laboratory with twelve different softwoods show that paper produced from rough wood chips (those with bark left on) is practically indistinguishable from paper produced with barkless chips. Although slightly more caustic for digesting, chlorine for bleaching, and some extra cleaning is necessary for the rough wood pulping, based on 1972 costs, the process actually shows a net savings of $4.68 per ton of bleached pulp produced. Absence of bark removal costs and a net gain in yield of acceptable pulp per rough cord of wood are the major areas responsible for cost reductions.

Lower costs, reduced pollution, and higher yields are goals of the Lab's non-sulphur pulping work. Research is directed at increasing pulp strength, solving chemical transport problems for oxygen pulping, and developing effective control systems. The first non-sulphur pulping symposium was conducted by the Laboratory and TAPPI in October of 1974.

The transportation and storage of wood chips, which will increase as more residues are used, have created some new headaches for paper producers. Massive chip piles are subject to spontaneous fire and attack by microorganisms. Degradation results in loss of wood substance, pulp yield and quality, chip brightness, and byproducts such as turpentine and tall oil.

Experimental results show that treating southern pine chips with solutions of sodium N-methyldithiocarbamate and sodium 2, 4-dinitrophenol was very effective in preventing heating and degradation for six months. The treatments are nonpolluting, nontoxic, compatible with pulping processes, inexpensive, and long lasting.



The chemicals were evaluated in laboratory tests with insulated boxes containing chips and in insulated towers that more closely approximate conditions in a chip pile. Further evaluations are being conducted in experimental outdoor chip piles at mill sites.

Several other promising chemicals of the more than 90 examined are being tested further. Methods for applying the chemicals to the chips are also being evaluated.

Wood is the paper industry's multiple resource - it serves both as raw material and fuel. Implementing FPL findings will insure that plentiful supplies of that valuable substance will be available in the future.

PROJECTS

PLASTIC — PAPER SEPARATION

The airstream used to separate paper from trash in the laboratory's waste paper recovery system cannot distinguish between the Sunday sports section and a plastic bag.

Engineers at the Forest Products Laboratory developed a dry thermal system to separate the plastic from the paper. It has been patented by the Laboratory for public use. (U.S. Pat. 3,814,240)

FPL engineers found that plastic film, suspended with paper in an airstream at about 250 to 350 degrees F, will contract upon itself and fall out of the air flow.

STRUCTURES FROM PARTICLES

Structural lumber and panels can be made by gluing together small boards, wood particles, or chips. However, control over materials used and processing methods employed is necessary to make products with desirable qualities of strength and stiffness.

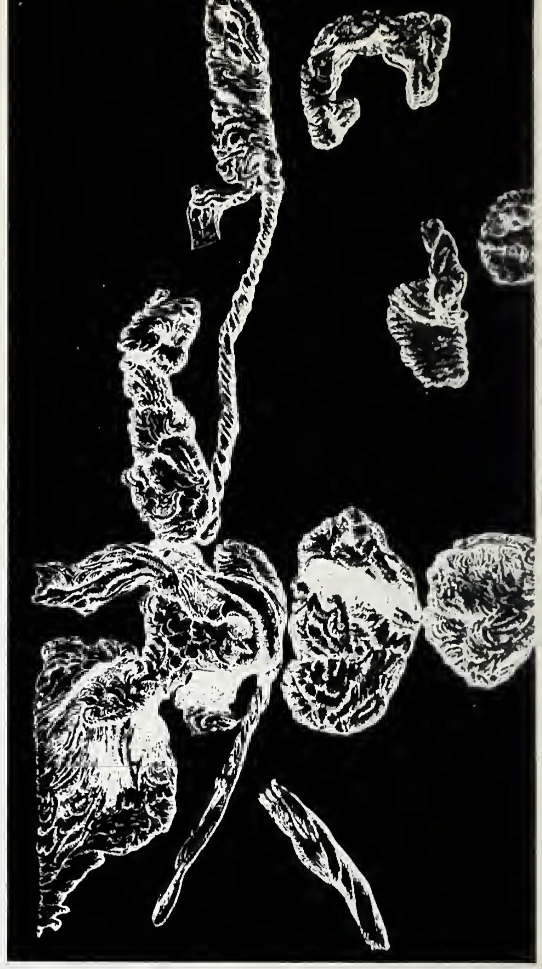
Laboratory findings offer several ways to increase particleboard strength when dealing with a wide range of raw materials including the particles obtained from forest residues. For instance, particleboards made from flakes approximately 2 inches long and .02 inches thick are considerably stronger than those made from other shape particles. Orientation of these flakes so their long axes all run in one direction increases strength in that direction.

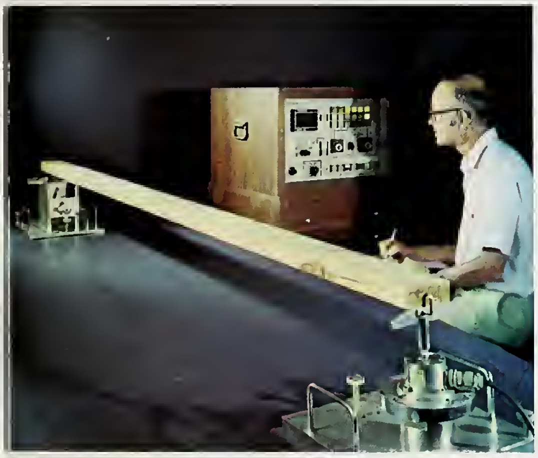
Strong particleboards can be made with low quality residues containing bark or decayed material if a face layer of oriented flakeboard is bonded to each side of a residue particle core. These layered boards are as strong as or stronger than more conventionally produced material.

Laboratory scientists are now exploring shaped particleboards for specialized use in wall, floor, and other building components.

IMPROVED WOOD FINISHING

The performance of finishes exposed outdoors may be improved by treatment of the wood's surface with inorganic chemical compounds such as ammonium chromate, chromic acid, copper chromate, copper-chrome-arsenate, cupriethylenediamine, copper molybdate, and copper ferrocyanide.





These treatments will enhance the durability of clear polymer coatings by retarding the harmful effects of ultraviolet light on the wood. The chemicals impart fungal resistance to the wood and surface coating, improve the adhesion of oil-based paint to summerwood, and inhibit staining of latex paint by fixing the extractives in redwood and redcedar.

Some of the chemicals being used in this research are toxic and may not be recommended for use by the public. The research includes a search for acceptable chemicals and definition of the conditions under which they may be safely used on wood.

NONDESTRUCTIVE TESTING

Lumber graded by visual methods varies widely in strength. Since the need for safety dictates caution, each grade is assigned a strength about equal to the weakest pieces permitted in the grade. The extra strength of the many stronger pieces goes unused.

Several electronic and mechanical nondestructive systems are being evaluated to offer better alternatives for lumber grading. They predict the strength of a board by measuring deflection during bending, its rate of vibration, or the speed at which a stress wave travels through it.

These systems work with any length or size of lumber. They are being examined for grading diverse lumber products and particleboard or fiberboard.

EGAR

In conventional sawing, a 9-1/2-inch log at its widest point will produce an 8-inch board with up to an inch and one-half of lumber lost in the edging.

However, Laboratory research on EGAR, a technically feasible edge-glue-and-rip system in which logs are cut into flitches that are edged as wide as possible, glued together into a large panel, and then resawed into lumber, indicates that this waste can be reduced.

Preliminary research shows that lumber recovery is increased more than 10 percent over conventional sawing and that EGAR lumber is as strong as that produced by standard methods.

DEFECTO—SCOPE

A Laboratory development called the defecto-scope can locate defects in a board and control the best way to saw that board. It sends ultrasonic signals — high frequency sound — through a board at points on a grid of preset size.

Constant "transit times" for the signal indicate clear wood—abrupt changes show changes in grain like that surrounding knots. A computer quickly evaluates the data and identifies clear areas in the board.

For research purposes, the computer then instructs a line plotter to draw the board, locate the clear areas, and show where saw cuts should be made to eliminate defects. Laboratory scientists feel that the computer can directly control saws cutting the board.

NEW TERMITE CONTROL

Termite damage runs into millions of dollars every year. A termite control system developed at the Laboratory may cut this waste.

It involves wood baits, infected with brown-rot fungus and treated with a little poison, then spaced in a row around a structure to be protected. The fungus gives off a chemical like the one termites use to mark trails to food. Poison on the bait kills the termites. The system is inexpensive, can be applied by the homeowner, and uses only 1/500 as much insecticide as soil poisoning.

NEW DIRECTIONS

From putting microorganisms to work to changing wood's chemical structure, testing whole houses, hardwood research, and economic analysis, the Laboratory is working in new areas for efficient utilization of the Nation's timber resource.

Laboratory scientists are trying to develop a mutant fungus that will attack only the lignin in wood and leave the cellulose fibers. This pulp can then be used for paper, animal feed, and numerous other applications. The action of several promising mutants is being studied with radioactive artificial lignin developed at the Laboratory.

Other FPL scientists are trying to prevent fungal action on wood by chemically modifying its structure. Certain alkylene oxides make wood resistant to fungal attack. This concept of chemically altering wood may have many applications and help bind glues or paints more firmly to the wood.

In the past, information for strength and safety of houses was based on the performance of parts and pieces, such as studs or joists. FPL engineers are now finding that finished houses act as a unit. First tests on an entire structure show that the conventional house is probably much stronger than it need be for safety. FPL scientists feel that the amount of structural lumber in a house could be substantially reduced.

Research is being strengthened on the hardwood resource which occupies 53 percent of the Nation's commercial forest land. The increasing stock of hardwood timber is decreasing in quality. The research challenge is to learn how to use more low-quality timber and how to STRETCH the high-quality trees.

The Laboratory recognizes that novel ideas will be implemented only if they are economically feasible. The new marketing and economics research work unit at the Laboratory has begun analyses of FPL technical innovations to identify their economic potential. The unit also is applying timber resource statistics and industry trade data to help pinpoint important research and development opportunities.

FOR MORE INFORMATION

The chief product of the Forest Products Laboratory is scientifically proven information. For information on wood products and processes, call or write the Laboratory and state your need. The number is (608)-257-2211 and mailing address is Forest Products Laboratory, Forest Service, U. S. Department of Agriculture, P.O. Box 5130, Madison, WI 53705.

The Laboratory's stock of over 3,000 publications and reprints and extensive slide and photograph file contain something for just about any request. Publications, reprints, photographs and slides are available free for limited quantity requests. The FPL Library will loan many of its materials to other libraries or institutions and will copy some material that it does not loan.

You may contact researchers directly by a personal visit, a telephone call, or a written message to explain your needs. The scientists and staff of the Forest Products Laboratory are usually available to help analyze and solve specific problems with the manufacture or use of wood-base materials.

PUBLICATIONS

TIMBER & ENVIRONMENT

1. The Wood Resource and the Environment—Some National Options and Alternatives. Saeman.
2. The Impact of Utilization Research on the Complete Use of the Forest. Fleischer.

CONSTRUCTION & ENGINEERING

3. FPL Houses Meet Needs of Low-Income Families. Sherwood.
4. Selection and Use of Wood Products for Home and Farm Building. Anderson.
5. Wood Structures Can Resist Hurricanes. Sherwood.
6. Condensation Problems in Your House: Prevention and Solution. Anderson and Sherwood.
7. Principles for Protecting Wood Buildings from Decay. Scheffer and Verrall.
8. Testing of a Full-Scale House Under Simulated Snowloads and Windloads. Tuomi and McCutcheon.
9. Advancements in Timber Bridges Through Research and Engineering. Tuomi.

WOOD PROCESSING

10. Increasing Softwood Dimension Yield From Logs—Best Opening Face. Hallock and Lewis.
11. Techniques for Peeling, Slicing and Drying Veneer. Lutz.
12. Veneer Species that Grow in the United States. Lutz.
13. Feasibility of Producing a High-Yield Laminated Structural Product—General Summary. Schaffer, Jokerst, Moody, Peters, Tschernitz, and Zahn.
14. If We Need It—Construction Plywood from Hardwoods is Feasible. Lutz and Jokerst.
15. Ultrasonic Location of Defects in Softwood Lumber. McDonald.
16. Automatic Programming and Control for Steam-Heated Lumber Dry Kilns. Wengert and Evans.
17. Properties of Structural Particleboards. Lehmann.

WOOD TREATING

18. Wood Siding: Installing, Finishing, Maintaining. Forest Products Laboratory.
19. Inorganic Surface Treatments for Weather-Resistant Natural Finishes. Black and Mraz.
20. Enzyme Mixture Improves Creosote Treatment of Kiln-Dried Rocky Mountain Douglas-fir. Tschernitz.
21. Attractant-Mirex Bait Suppresses Activity of **Reticulitermes** Spp. Esenther and Beal.

PULP & PAPER

22. Economics of Kraft Pulping of Unbarked Wood. Horn and Auchter.
23. Effective Dry Methods of Separating Thermoplastic Films from Wastepapers. Laundrie.
24. A Practical Method for Recycling Wax Treated Corrugated. Mohaupt and Koning.
25. An Evaluation of Four Chemicals for Preserving Woodchips Stored Outdoors. Springer, Haslerud, Fries, Clark, Hajny, and Zoch.
26. Lignin Biodegradation and the Bioconversion of Wood. Kirk and Harkin.

WORKING WONDERS WITH WOOD